

Image Analysis

Karel Martínek

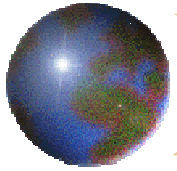
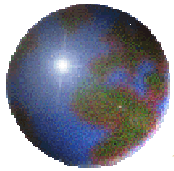


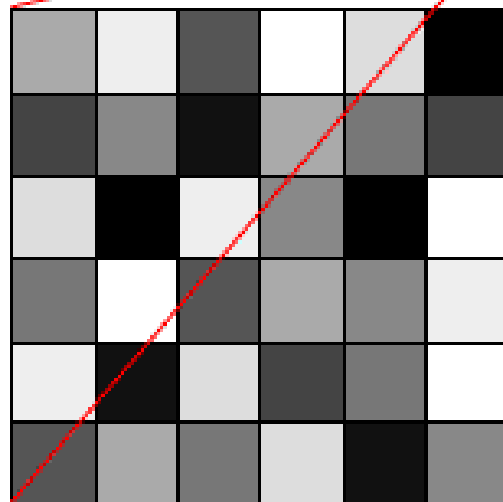
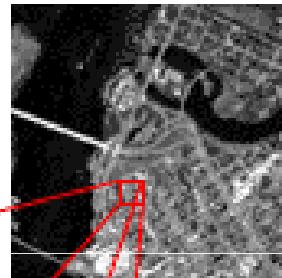
Image analysis

- visual interpretation
- digital processing
 - preprocessing (radiometric and geometric corrections, ...)
 - image enhancement (contrast manipulation, spatial filtering, ...)
 - image transformation (band ratios, principal component analysis, ...)
 - classification (unsupervised, supervised)

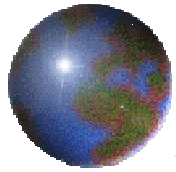


images

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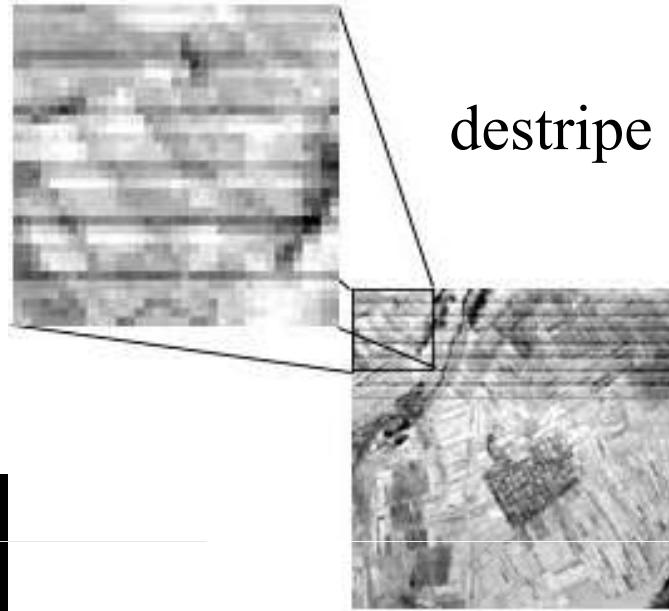
170	238	85	255	221	0
68	136	17	170	119	68
221	0	238	136	0	255
119	255	85	170	136	238
238	17	221	68	119	255
85	170	119	221	17	136



preprocessing

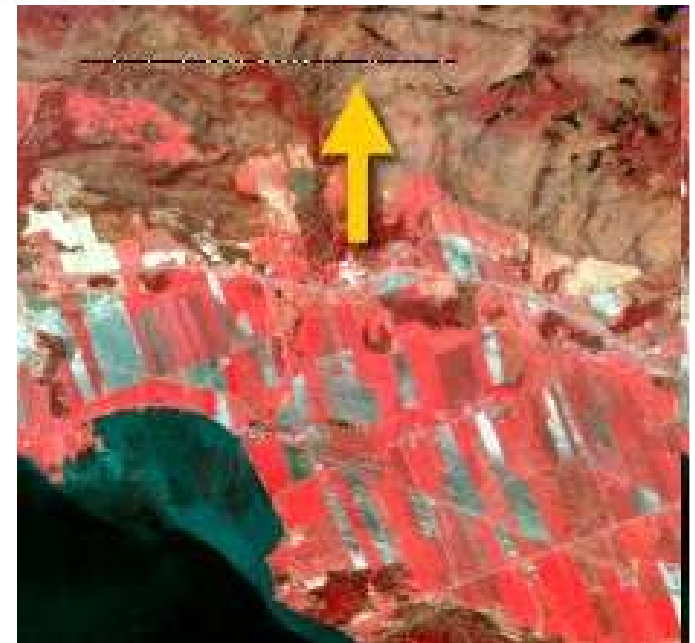
radiometric corrections

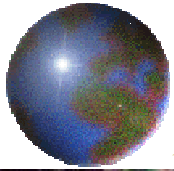
mosaicking



destripe

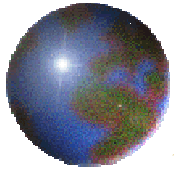
replace bad lines



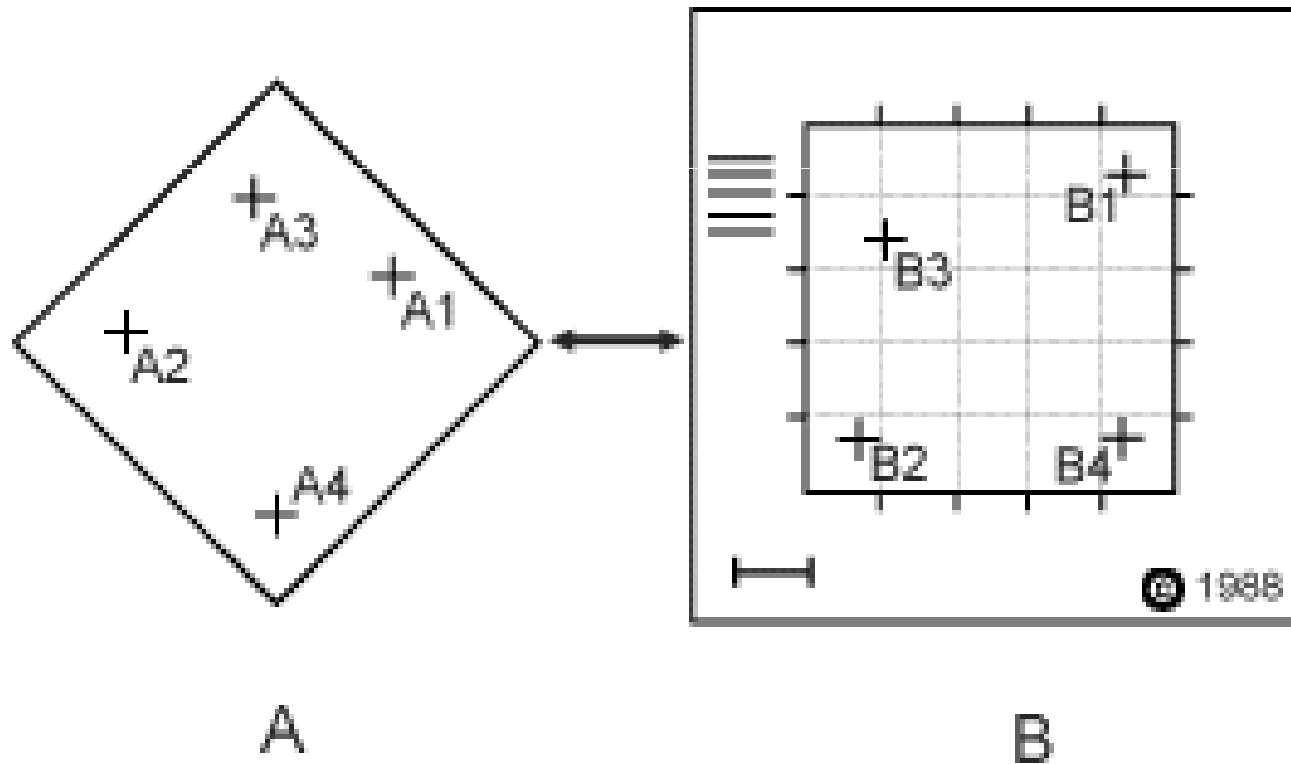


atmospheric corrections





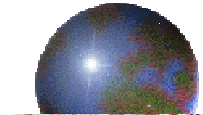
Rectification (geometric correction, geometric registration, georeferencing)



spectral band combination



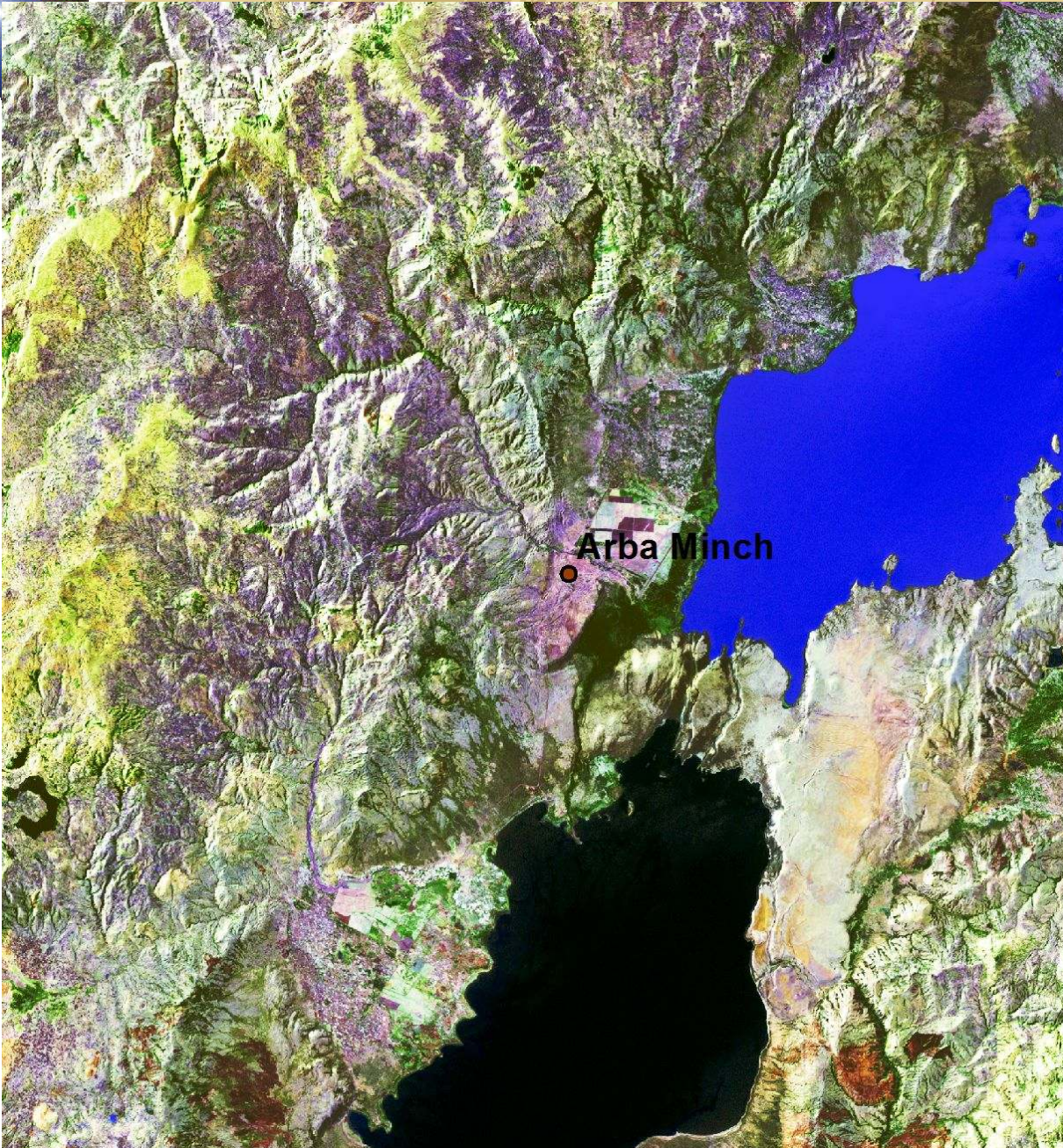
TM 321 RGB



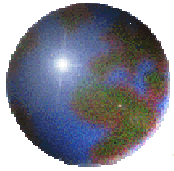
TM 432 RGB



TM 531 RGB

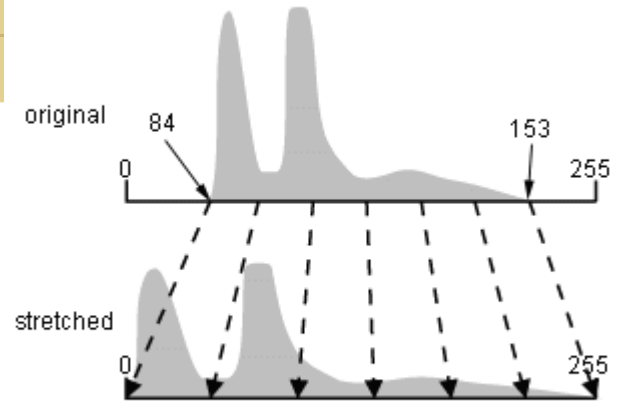
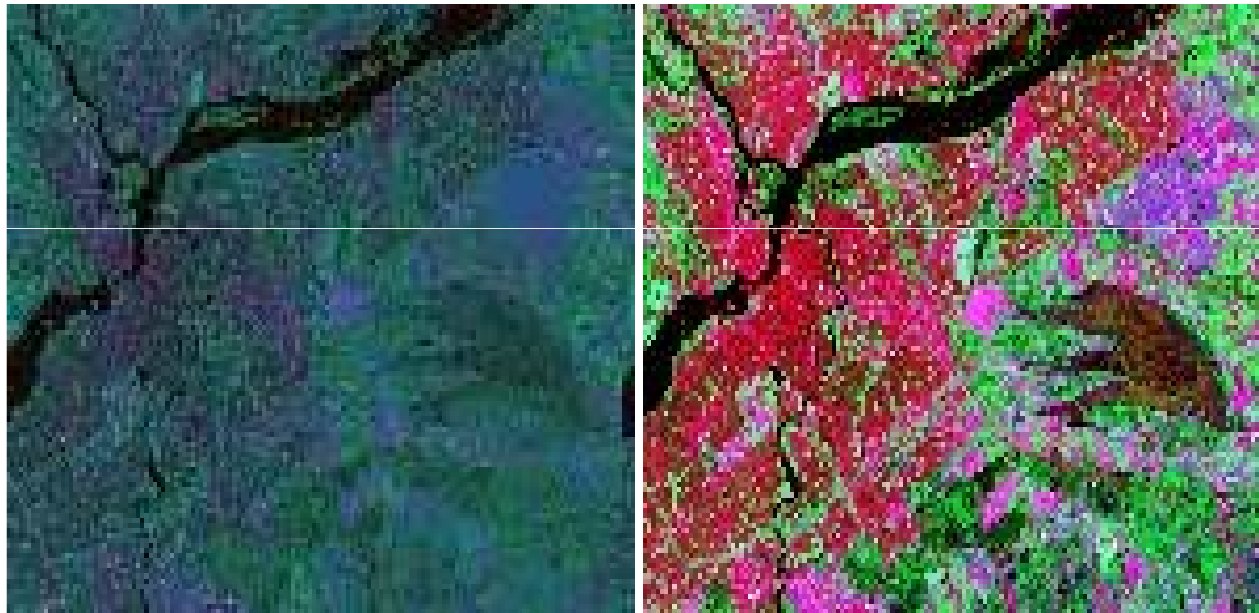


TM 753 RGB



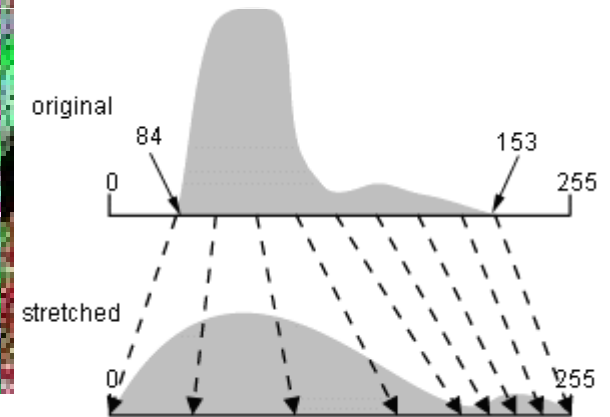
contrast enhancement

histogram stretch



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linear



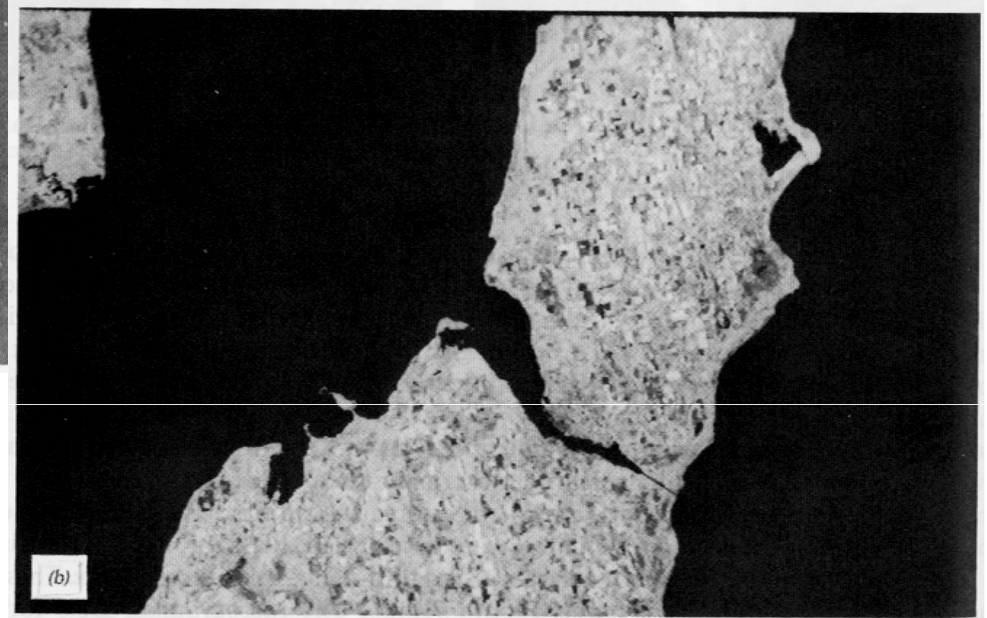
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histogram equalize



TM1

histogram



TM4

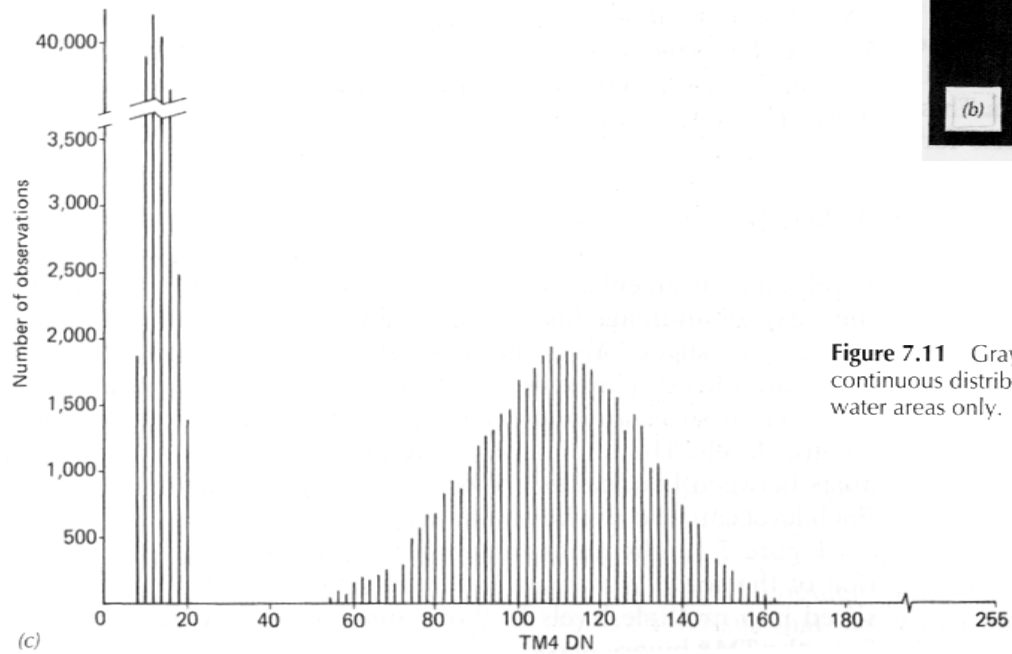
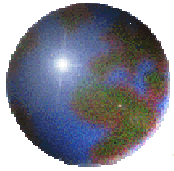


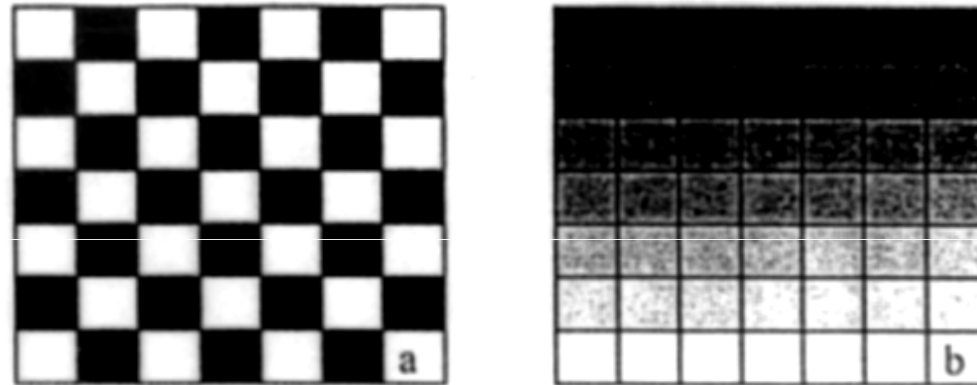
Figure 7.11 Gray-level thresholding for binary image segmentation: (a) original TM1 image containing continuous distribution of gray tones; (b) TM4 image; (c) TM4 histogram; (d) TM1 brightness variation in water areas only.



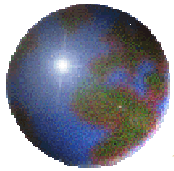
TM1 water features, masked land



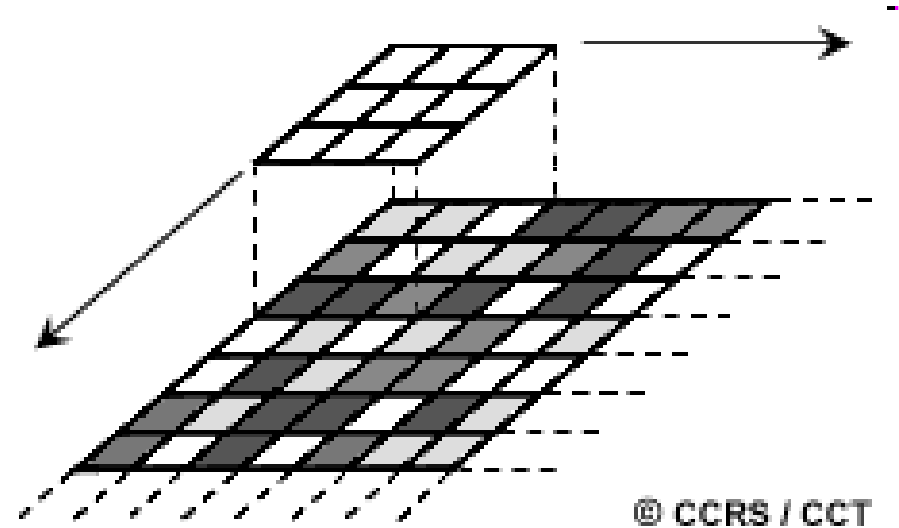
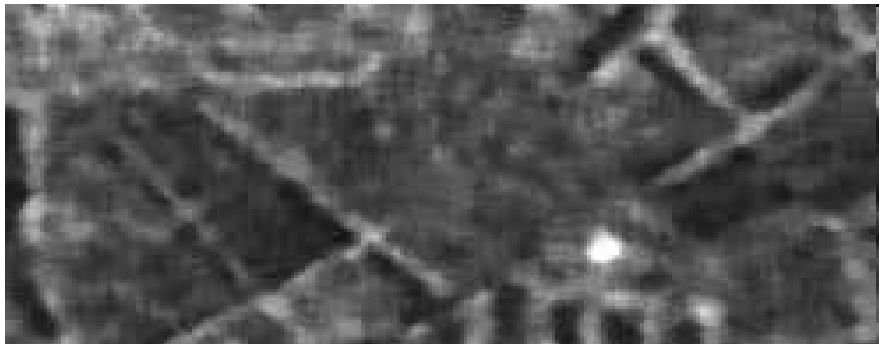
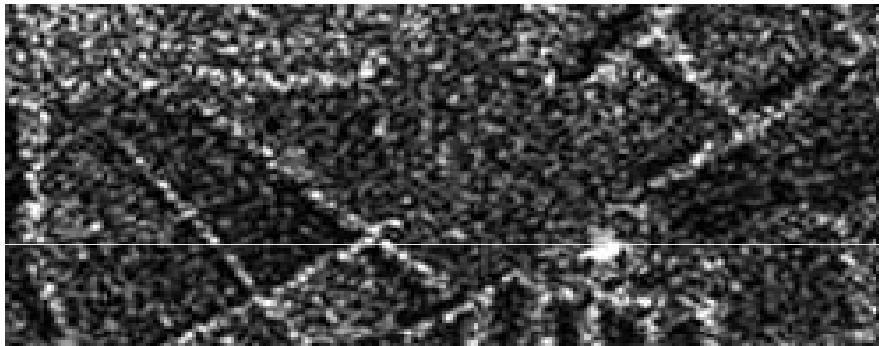
spatial filtering- kernels



Obr. 8.8 Příklad vysokofrekvenční (a) a nízkofrekvenční (b) informace v obraze



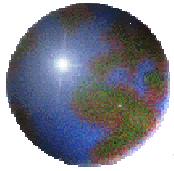
low-pass filter



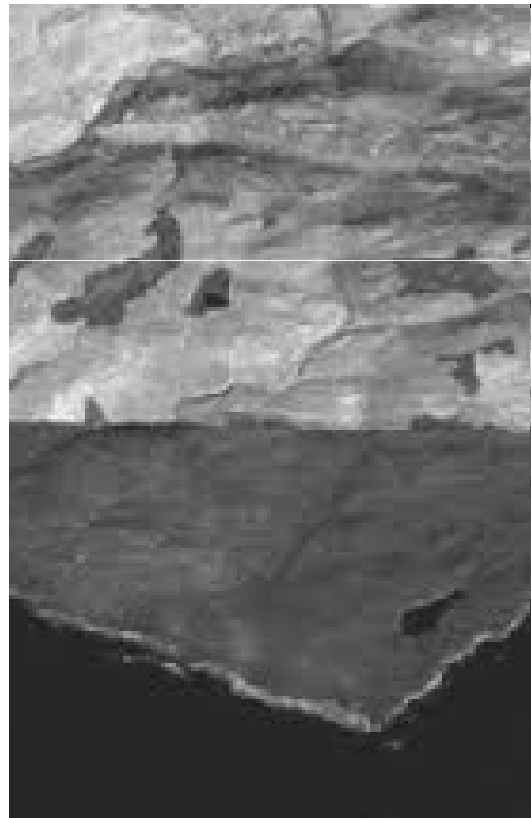
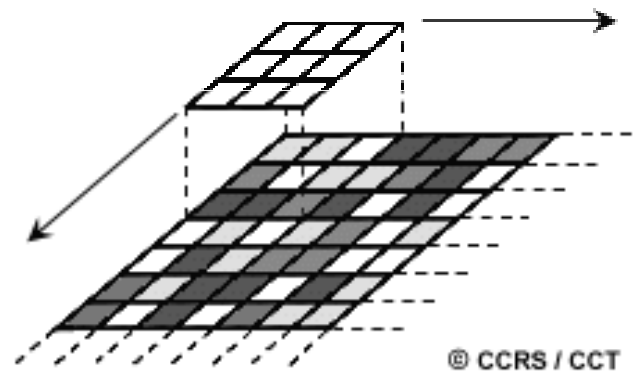
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Figure 7.10 Result of applying noise reduction algorithm: (a) original image data with noise-induced “salt-and-pepper” appearance; (b) image resulting from application of algorithm shown in Figure 7.9.



high-pass/sharpen filter



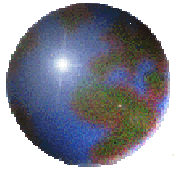
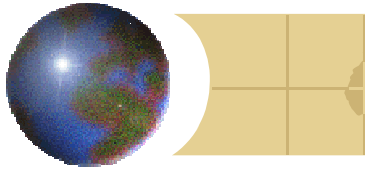


image transformation

- ⊕ algebraic operations with spectral bands
- ⊕ principal component analysis



band ratios

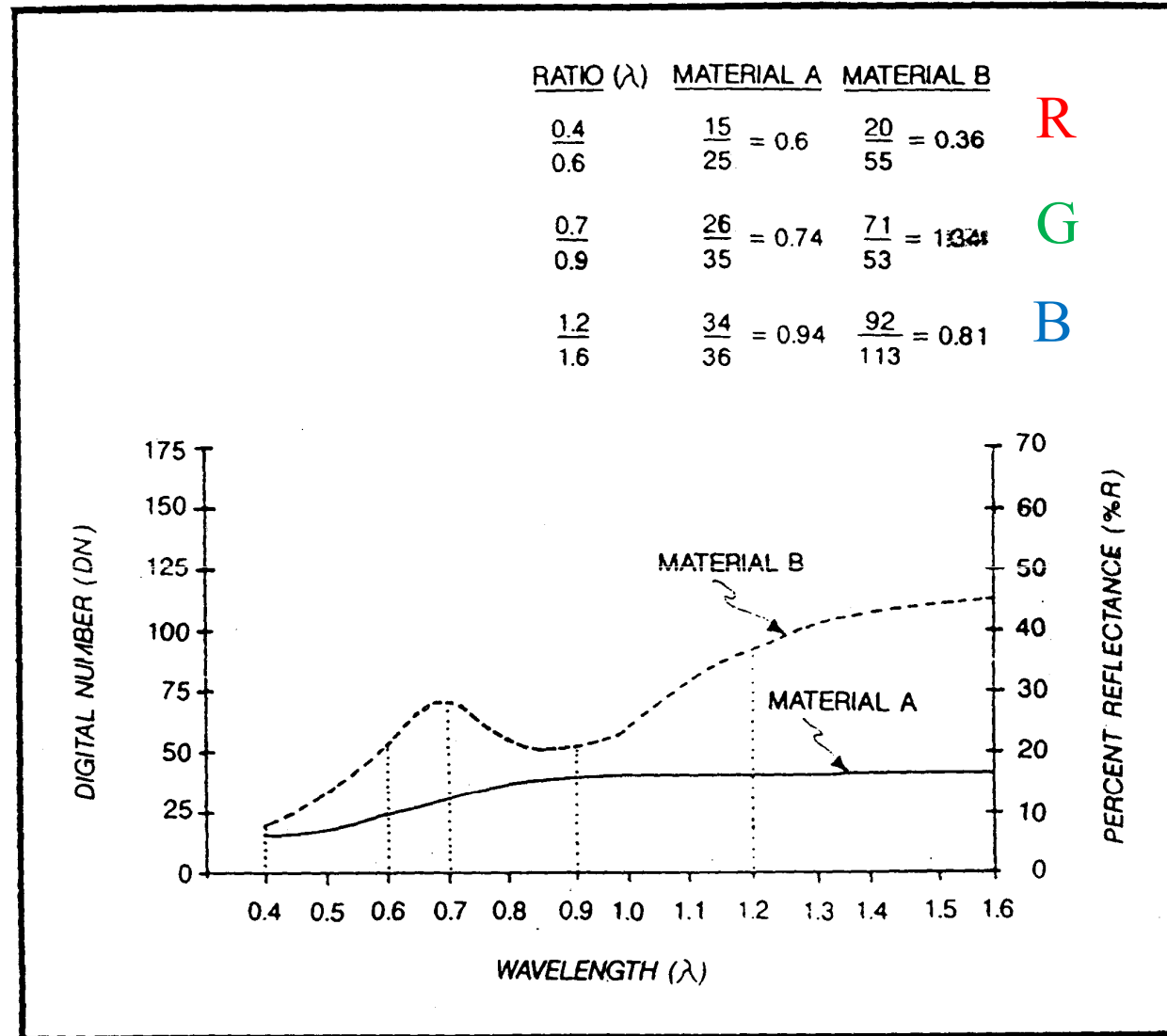
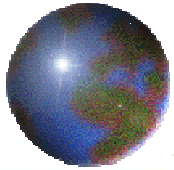


Figure 6.1 Hypothetical reflectance curves showing how ratios enhance minor reflectance variations. From Prost [6].



TM 5/4 3/1 5/7 as RGB

HSI transformation

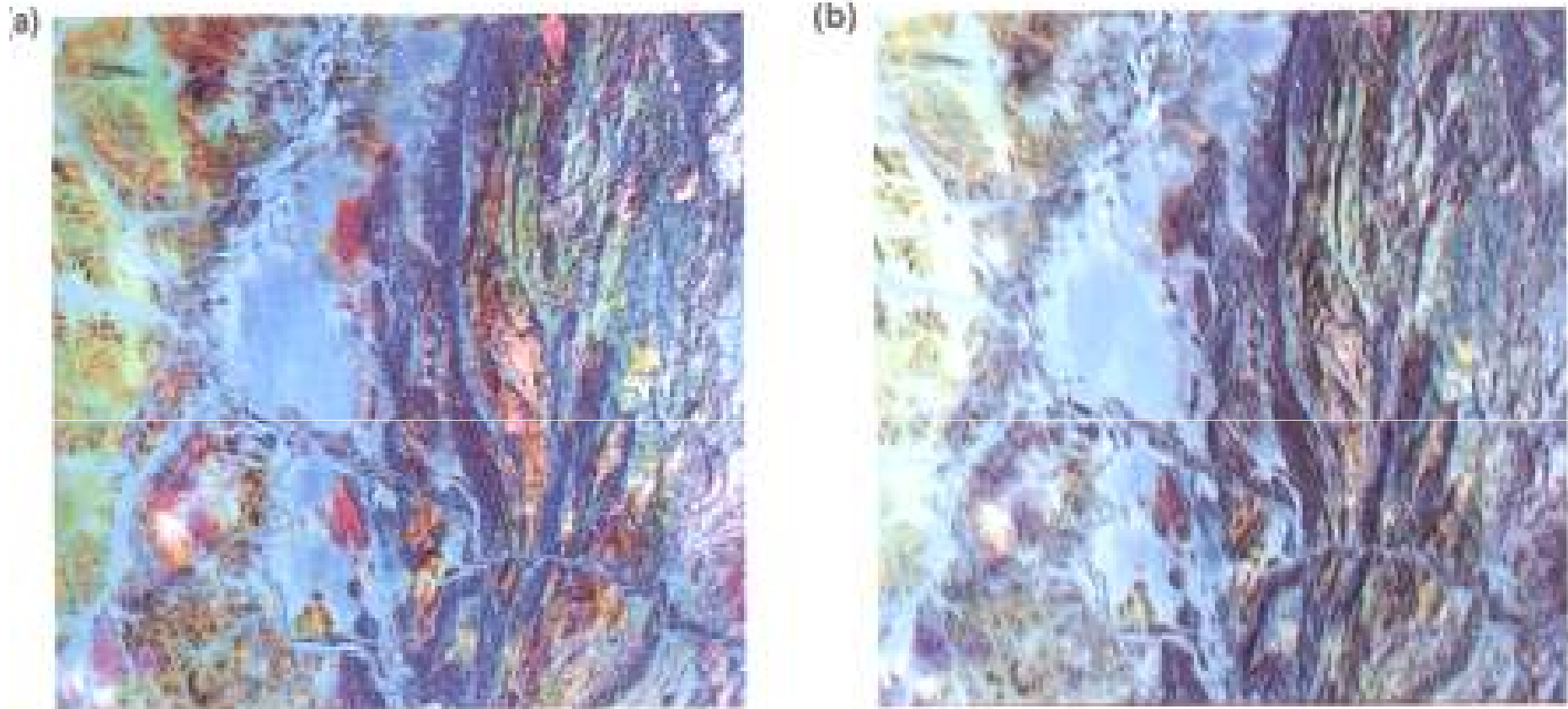
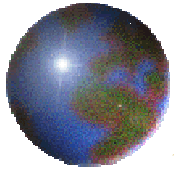


Figure 5.30 (a) False-colour ratio image of the area of Figure 5.31, using TM 5/4 as red, 3/1 as green and 5/7 as blue. Though producing an excellent discrimination of rock types, the image lacks some topographic detail and is noisy. By using the HSI transform and substituting a contrast-stretched TM band for the ratio intensity, (b) both defects can be avoided without changing the colour rendition of different rocks, which is dependent on spectral features related to iron minerals, albedo and hydroxy-bearing minerals. Both should be compared with *Figures 5.14* and *5.26*.



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TM vegetation index

$$Y = \frac{TM4 - \text{Min}(TM4)}{TM3 - \text{Min}(TM3)} \quad (4-11)$$

$$Y = \frac{TM4 - TM3}{TM4 + TM3} \quad (4-12)$$

TM clay mineral ratio index

$$Y = \frac{TM5 - \text{Min}(TM5)}{TM7 - \text{Min}(TM7)} \quad (4-13)$$

ATM clay mineral difference index

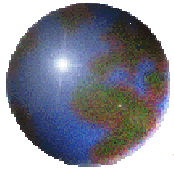
$$Y = (ATM9 + ATM4) - (ATM10 + ATM2) \quad (4-14)$$

TM iron oxide ratio index

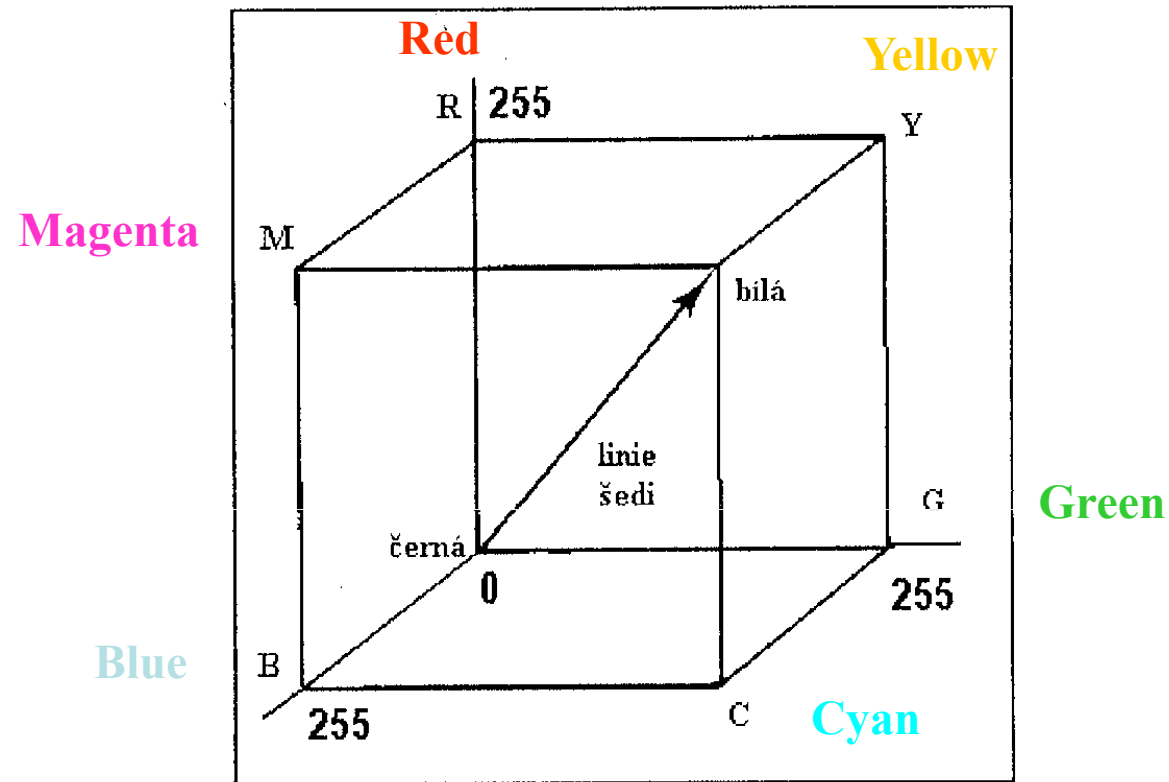
$$Y = \frac{TM3 - \text{Min}(TM3)}{TM2 - \text{Min}(TM2)} \quad (4-15)$$

ATM gypsum enhancement colour composite

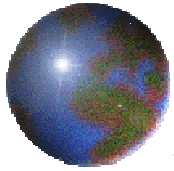
$$\begin{aligned} \text{Red} & ATM9 - ATM10 \\ \text{Green} & ATM8 - ATM10 \\ \text{Blue} & ATM2 - ATM10 \end{aligned} \quad (4-16)$$



RGB color system



Obr. 8.17 Princip RGB barevného systému, RGB - základní barvy (červená, zelená a modrá), CMY - barvy komplementární (Cyan - azurová, Magenta - purpurová, Yellow - žlutá)



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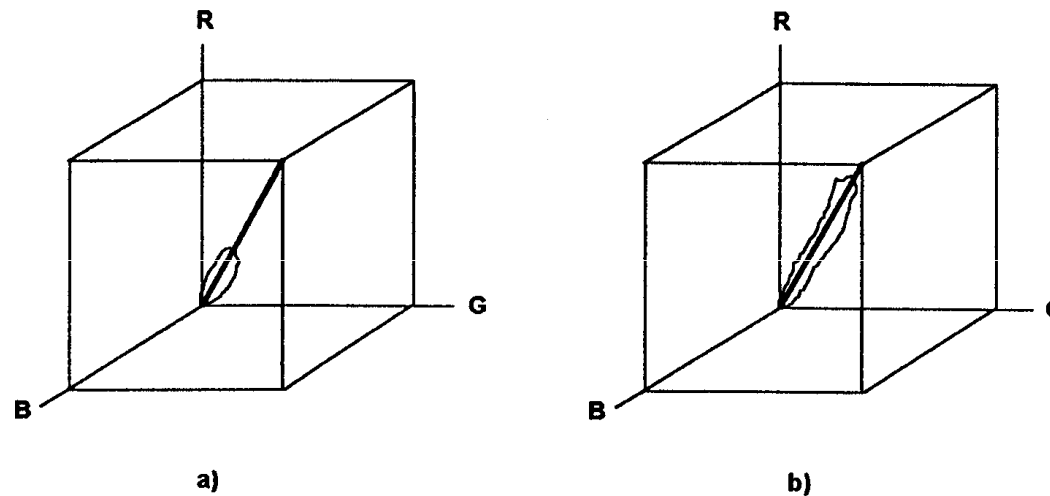
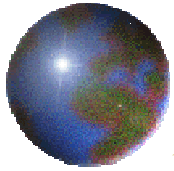
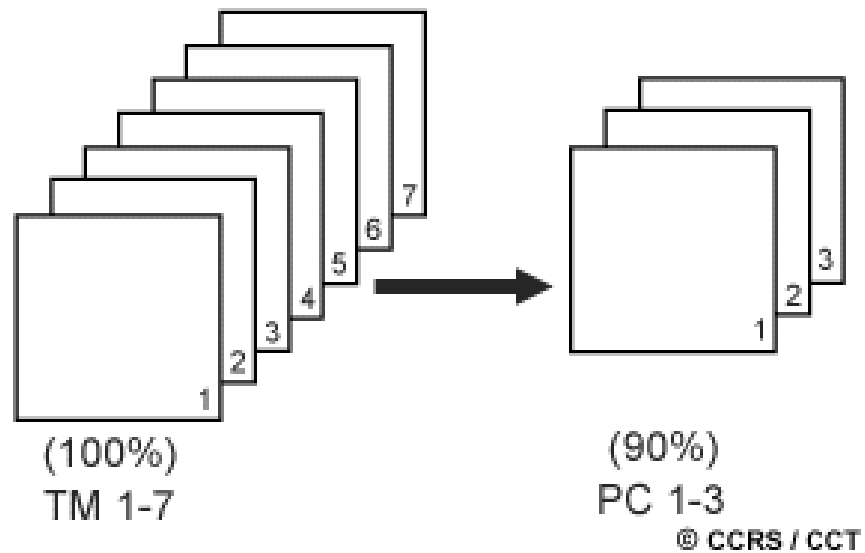


Figure 6-2 (a) Distribution of pixels in RGB cube for typical correlated bands. (b) Effect of stretching each band. The data is not stretched to fill the RGB cube by this operation.



✪ principal component analysis (PCA)



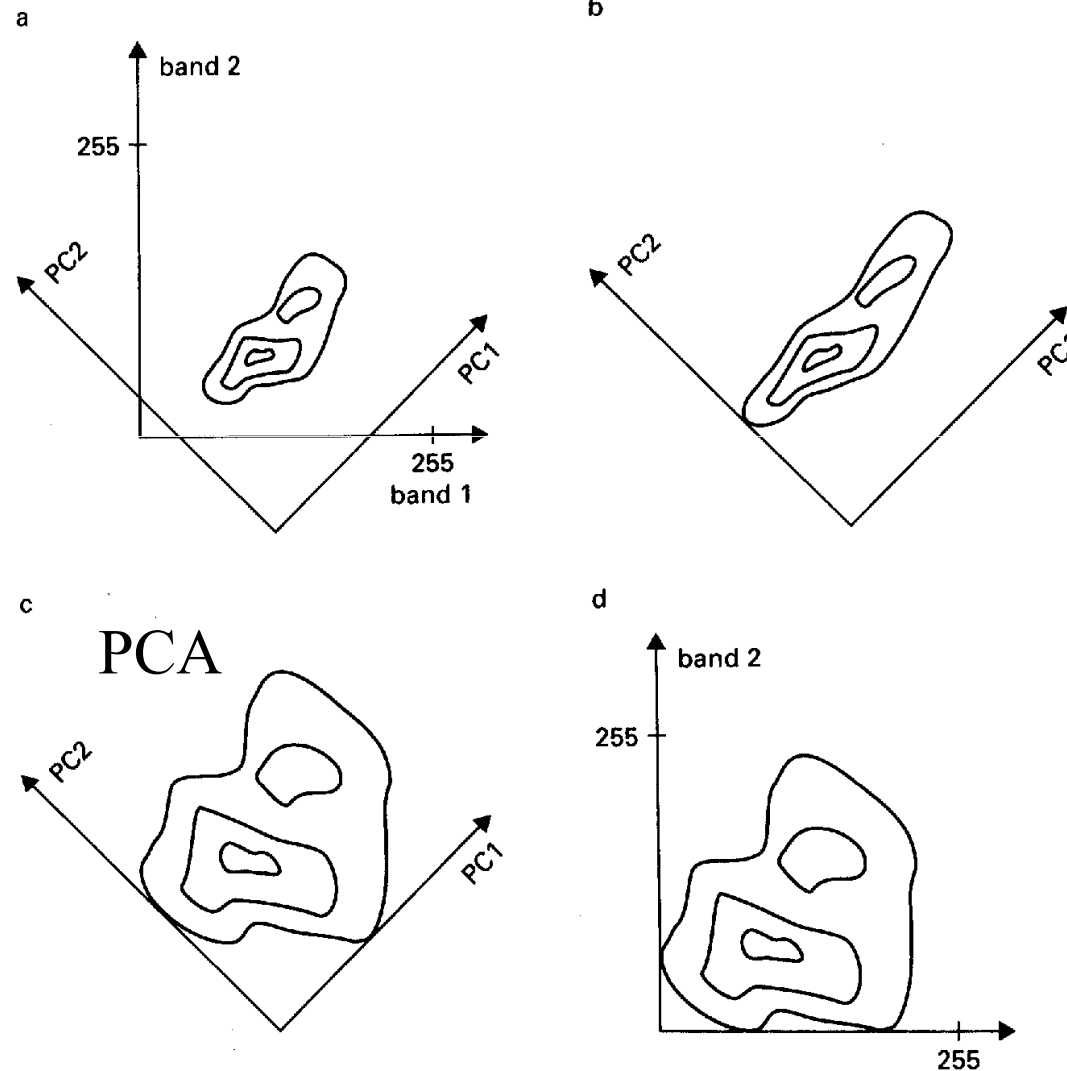
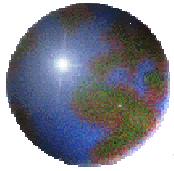
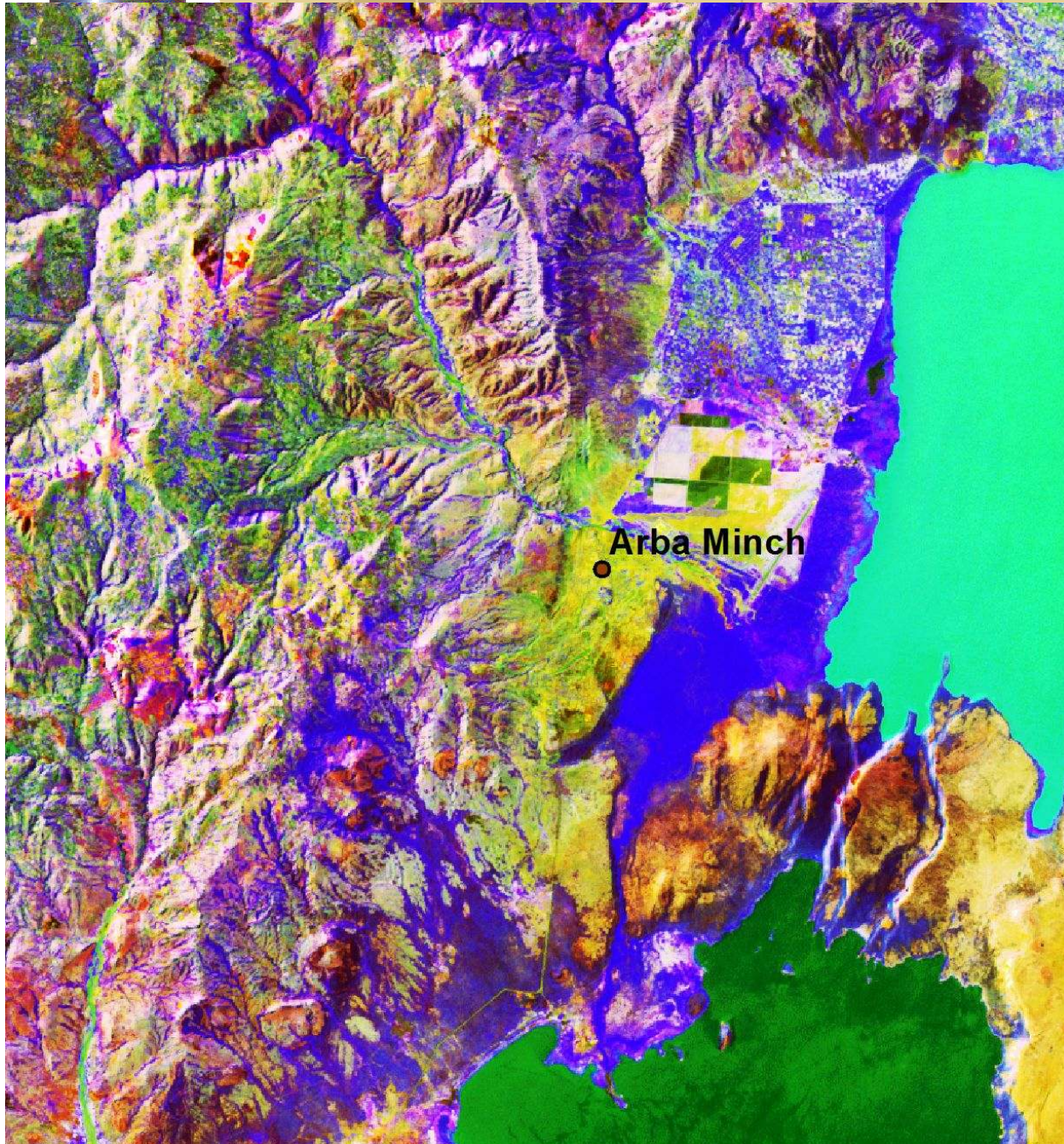


Figure 5.27 (a) A bivariate plot of two bands with PC axes superimposed. In (b) the first PC has been stretched after rotation of the axes to PC space, the second PC having been stretched in (c). This shows how it is possible to produce a decorrelation of the data in PC space. (d) The decorrelated data have been rotated back to original band space, the original correlation having been drastically reduced, although each pixel is still in its original position relative to all the others. Compare with Figure 5.12.



PC1, PC2, PC3
as RGB